

1

General Introduction to Canine and Feline Parasitic Diseases

Sanweer Khatoon

Department of Veterinary Parasitology, CVAS, Navania, Udaipur, India

1.1 Introduction

In parasitology, a parasite is an organism that benefits from its host without returning any benefits and usually causes some damage to it. Incidentally, parasites constitute a diverse group of organisms that may affect a wide range of animal hosts, including amphibians, birds, fishes, mammals, and reptiles. Parasites are unwelcome guests. The word parasitism literally means living side by side. No organism is known that is not susceptible to attack by parasites of some sort. Therefore, a parasite is an organism that resides on or in the body of a larger living organism and derives nourishment from its tissues.

In the twenty-first century, parasitic diseases are still a severe burden on animal and human populations in tropical and subtropical regions around the world. The impact of parasitic diseases is disproportionately higher in low-income countries like India because the average living conditions favor exposure to certain parasites whose transmission may be associated with poor housing and sanitary conditions as well as access to education and primary healthcare services.

The dog, a domesticated mammal of family Canidae and the order Carnivora with scientific name *Canis lupus familiaris* is a subspecies of gray wolf related to foxes and jackals. They are the most ubiquitous and popular domestic animals in the world. On other hand, cats (*Felis catus*) are a domestic species of small carnivorous mammal and is the only domesticated species of family Felidae. They are commonly referred to as domestic or house cats. Both species are commonly kept as house pets, and domestic cats are valued by humans for companionship and their ability to kill rodents. Pet dogs and cats are often considered the faithful friends and intimate companions of humans. The human–animal bond provides emotional development,

socialization, and physiological wellbeing. But with the increase in the number of companion animals is increased contact between domestic animals and people, which exposes humans to zoonotic agents. Although dogs and cats are often considered family members by their owners, it is important to emphasize that they may play an important role as hosts for transmitting zoonotic diseases to humans [1, 2]. Likewise, the potential role of companion animals as reservoirs for zoonotic diseases has been recognized as a significant public health threat of pet ownership worldwide [2].

In general, dogs and cats contribute to the general wellbeing of their owners, particularly children. Despite these benefits to humans, some endoparasitic infections and ectoparasitic infestations of dogs and cats pose a great threat to public health due to the zoonotic problems associated with their occurrence. Parasitic diseases of dogs and cats cause various infections like ocular larva migrans, neurologic, dermatologic, respiratory, and enteric disorders in humans. Rural areas have been implicated as factors in the spread of these zoonotic parasites [3]. However, factors such as biotic potential, high stocking density, and suppressed immune level favor the spread of parasitic diseases. Thereby, parasites are a great threat to society. Many dog owners have found that a single parasite can adversely affect the dog's welfare and thus cannot be tolerated. So, parasite diagnostics and anti-parasitic treatments have a significant role in everyday animal care. Some canine parasite infections, even those with no or minor effects on the dog itself, are zoonotic [4].

Dogs are useful companion animals and used for security purposes, breeding activities, and dog shows. Dog practices are up and coming but there are reports of various parasitic disease emerging in them. Tropical countries, including India, have favorable climatic conditions for parasitic

growth and development. Parasites can be transferred from dogs and cats to humans in a number of ways. These companion animals can act as the source of parasite stages that are infective to humans, either directly or following an essential period of development; dogs and cats can provide a reservoir for parasites that are indirectly transmitted to humans via intermediate and paratenic hosts or insect and arthropod vectors. From a public health point of view, most gastrointestinal (GI) parasites that infect dogs and cats are zoonotic and may result in serious disease in humans. The canine and feline zoonotic GI parasites of major public health importance in the first category include *Echinococcus granulosus*, *Toxocara cati*, *T. canis*, and the hookworms. Parasites of major zoonotic significance in the second category include food-borne trematodes (*Clonorchis sinensis*, *Opisthorchis viverrini*, *Paragonimus* spp.), *Gnathostoma spinigerum*, *Leishmania infantum*, and *Trypanosoma cruzi*, whereas *Toxoplasma gondii* may be transmitted by both direct and indirect methods.

The world's population of domestic dogs and cats is estimated at one billion, with stray animals thought to account for the majority. This considerable number of stray companion animals presents a serious concern for both human and animal welfare and places a significant burden on communities. This chapter deals with the various endoparasites that are of prime importance in dog and cats and for which an owner should always take proper care.

Among various dog and cat parasites, the helminths are worm-like parasites. They are both hermaphroditic and bisexual species. The classification is mainly based on the external and internal morphology of egg, larval, and adult stages.

Parasitic infections, in general, are spread in a number of ways. Protozoa and helminths spread through contaminated water, food, waste, soil, and blood. Some are passed through sexual contact. Other parasites are spread by insects that act as a vector, or carrier, of the disease (Figures 1.1–1.4).

Serial no.	Parasite name	Intermediate host
1	<i>Heterophyes heterophyes</i>	1st Snails 2nd Fishes (<i>Mugil cephalus</i>)
2	<i>Opisthorchis tenuicollis</i>	1st Fresh water snails 2nd Cyprinid fishes
3	<i>Opisthorchis viverrini</i>	1st Fresh water snails 2nd Cyprinid fishes
4	<i>Clonorchis sinensis</i>	1st Snails 2nd Cyprinid fishes

Serial no.	Parasite name	Intermediate host
5	<i>Echinochasmus perfoliatus</i>	1st Snails 2nd Fishes
6	<i>Artyfechinostomum sufrartyfex</i>	1st <i>Lymnaea luteola</i> (snail) 2nd <i>Barbus stigma</i> (fish)
7	<i>Paragonimus westermanii</i>	1st Snails 2nd Crayfishes, crabs
8	<i>Paragonimus kellicoti</i>	1st Snails 2nd Crayfishes, crabs
9	<i>Schistosoma incognitum</i>	Snails
Cestodes		
10	<i>Dipylidium caninum</i>	1st Dog fleas 2nd Dog louse
11	<i>Taenia hydatigena</i>	Domestic, wild ruminants
12	<i>Taenia ovis</i>	Sheep, goats
13	<i>Taenia pisiformis</i>	Rabbits, rodents
14	<i>Taenia taeniaeformis</i>	Rodents
15	<i>Taenia multiceps</i>	Sheep, goats
16	<i>Echinococcus granulosus</i>	Ungulates, humans
17	<i>Echinococcus vogeli</i>	Humans
18	<i>Diphyllobothrium latum</i>	1 st Diaptomus, cyclops 2nd Fresh water fishes
19	<i>Spirometra</i>	1st Water cyclops 2nd Water snakes, birds, mice, humans
Nematodes		
20	<i>Toxocara canis</i>	
21	<i>Toxascaris leonina</i>	
22	<i>Strongyloides stercoralis</i>	
23	<i>Ancylostoma caninum</i>	
24	<i>Ancylostoma tubaeforme</i>	
25	<i>Ancylostoma braziliense</i>	
26	<i>Filaroides osleri</i>	
27	<i>Thelazia callipaeda</i>	Musca
28	<i>Spirocerca lupi</i>	Coprohagous beetles
29	<i>Physaloptera praeputialis</i>	Beetles
30	<i>Gnathostoma spinigerum</i>	1st Cyclops 2nd Fresh water fishes
31	<i>Dirofilaria immitis</i>	Culicine mosquitoes
32	<i>Trichinella spiralis</i>	
33	<i>Trichuris vulpis</i>	
34	<i>Isospora canis</i>	
35	<i>Isospora felis</i>	

Serial no.	Parasite name	Intermediate host
36	<i>Diioctophyma renale</i>	Free-living <i>Liogochaete</i> annelid
Lice/fleas/mites/ticks (Figure 1.5)		
37	<i>Trichodectes canis</i>	
38	<i>Felicola subrostratus</i>	
39	<i>Linognathus setosus</i>	
40	<i>Heterodoxus spiniger</i>	
41	<i>Triatomine bug</i>	
42	<i>Ctenocephalides canis</i>	
43	<i>Ctenocephalides felis</i>	
44	<i>Pneumonyssua caninum</i>	
45	<i>Otobius megnini</i>	
46	<i>Rhipicephalus sanguineus</i>	
47	<i>Haemaphysalis leachi leachi</i>	
48	<i>Dermacentor variabilis</i>	
49	<i>Demodex canis</i>	
50	<i>Sarcoptes scabiei var canis</i>	
51	<i>Notoedres cati</i>	
52	<i>Otodectes cynotis</i>	
53	<i>Linguatula serrata</i>	Cattle, sheep, goats
Protozoa		
54	<i>Trypanosoma rangeli</i>	Triatomid bugs
55	<i>Trypanosoma cruzi</i>	Reduviid bugs
56	<i>Trypanosoma evansi</i>	Tabanus
57	<i>Leishmania tropica</i>	<i>Phlebotomus papatasi</i> , <i>Phlebotomus sergenti</i>
58	<i>Giardia canis</i>	
59	<i>Entamoeba histolytica</i>	
60	<i>Entamoeba coli</i>	
61	<i>Entamoeba gingivalis</i>	
62	<i>Sarcocysts cruzi</i>	Cattle
63	<i>Sarcocysts fusiformis</i>	Buffalo
64	<i>Sarcocysts hirsuta</i>	Cattle
65	<i>Toxoplasma gondii</i>	
66	<i>Neospora caninum</i>	
67	<i>Hepatozoon canis</i>	<i>Rhipicephalus sanguineus</i>
68	<i>Babesia canis</i>	<i>Rhipicephalus sanguineus</i>
69	<i>Babesia gibsoni</i>	<i>Rhipicephalus sanguineus</i> (Figure 1.6)
70	<i>Ehrlichia canis</i>	<i>Rhipicephalus sanguineus</i>

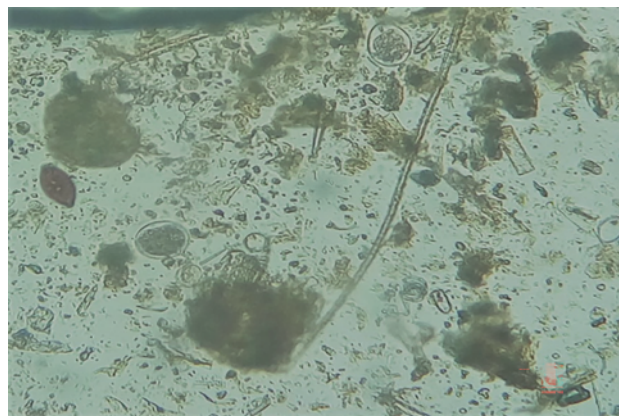


Figure 1.1 Ova of *Strongyle sp.* and *Trichuris sp.*

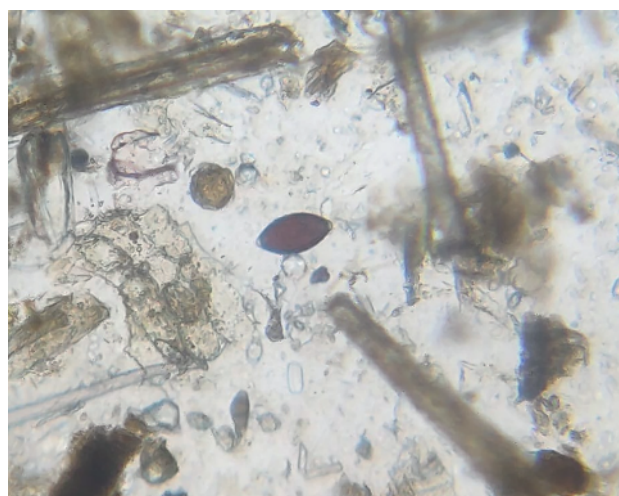


Figure 1.2 Ova of *Trichuris sp.*

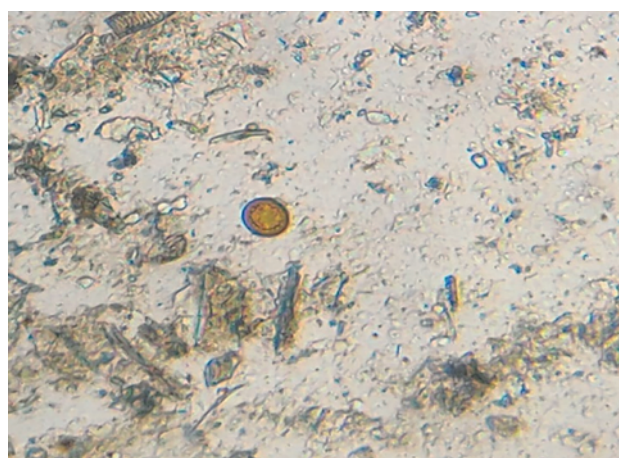


Figure 1.3 Ova of *Toxocara sp.*

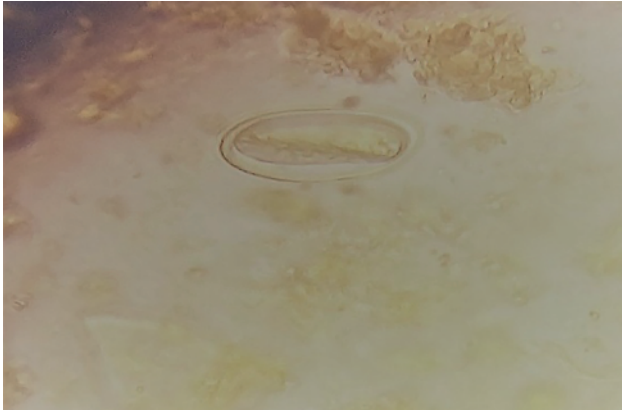


Figure 1.4 Ova of *Strongyloides* sp.



Figure 1.5 *Rhipicephalus sanguineus*

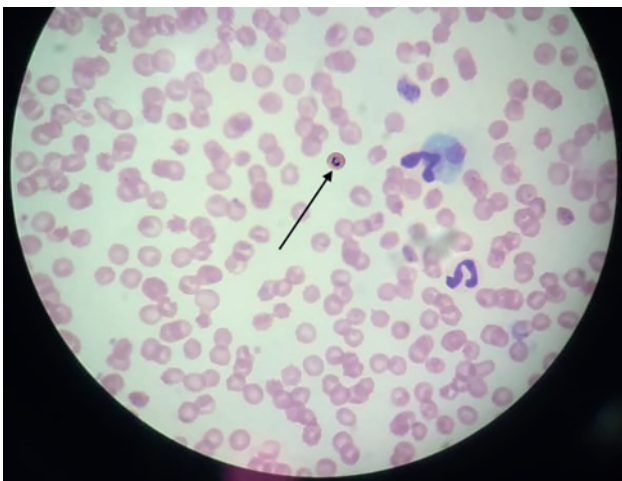


Figure 1.6 *Babesia* sp.

Intestinal parasites of dogs and cats are ubiquitous worldwide. The overall prevalence of intestinal parasites in pet dogs and cats varies considerably. With regard to helminthic infections, hookworms, ascarids, and whipworms are the most frequent intestinal parasites in dogs. In cats, *T. cati* is the most common helminth. Several factors affect observed variability in intestinal parasite infections, such as individual features of the host, management, heartworm prophylactic treatments, and diagnostic techniques. Furthermore, canine and feline helminths are susceptible to the effects of environmental conditions and to climate change due to their developmental stages and their survival periods in the environment. Diagnosis relies on polymerase-chain reaction (PCR) and antigen detection, which seems to be more sensitive than copro-microscopic analysis.

The most common signs and symptoms of intestinal parasites are: diarrhea, with or without blood or mucus, scooting, vomiting, distended abdomen (belly), weight loss, decreased activity, and a dull coat (Figure 1.7).

Pets become infected with intestinal parasites in a number of ways, including:

- Drinking contaminated water.
- Coming in contact with other infected animals.
- Coming in contact with fecal material containing parasite eggs or larvae.
- Swallowing fleas that are carrying the infective stage of tapeworms.
- Nursing from an infected mother.
- Predation or hunting, which, through ingestion, transmits the parasite from an infested or infected rodent or another hunted animal.

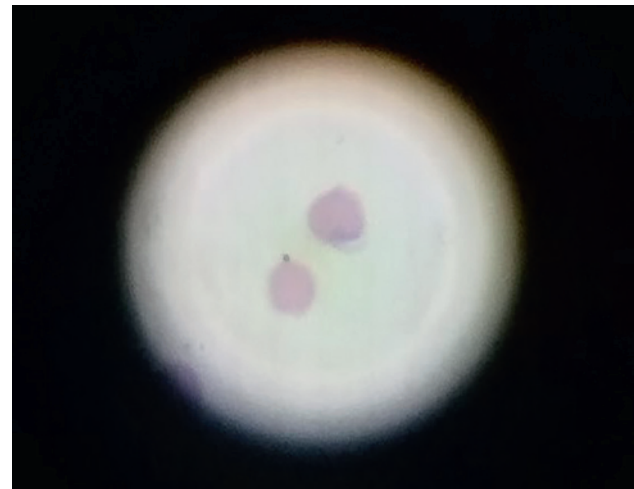


Figure 1.7 *Anaplasma* sp.

1.2 Type of Intestinal Parasites

Flukes (Trematodes)

- Adult flukes are leaf-shaped flatworms. They have prominent oral and ventral suckers, which help maintain their position in situ. They are hermaphroditic, except for blood flukes, which are bisexual. The life cycle includes an intermediate snail host.

Tapeworms (Cestodes)

- Adult tapeworms are elongated, segmented, hermaphroditic flatworms that inhabit the intestinal lumen. Larval forms, which are cystic or solid, inhabit extraintestinal tissues.

Roundworms (Nematodes)

- Adult and larval roundworms are bisexual, cylindrical worms. They inhabit intestinal and extraintestinal sites. They have a smooth, narrow, non-segmented body that is tapered at both ends. Most species are microscopic, with separate sexes, that are free living and occur worldwide. Included are heartworms, *Angiostrongylus*, roundworms, hookworms, whipworms, lungworms, threadworms, eyeworms, and others.

Roundworms: These are the most common intestinal parasites found in dogs and cats. They do not attach to the intestinal wall. Instead, roundworms live in the intestines and consume partially digested food. Eggs are passed into the stool. Roundworms are transmitted to puppies or kittens before birth by the mother. This is true even if the mother tests negative for roundworms because the larvae (immature worms) encyst in the mother's muscle tissue and are not detected by tests for adult worms. Another major source of roundworm infection for puppies and kittens is the mother's milk. Roundworm larvae may be present in the mother's mammary glands (transmammary route) and milk throughout the nursing period. Pets may also become infected by swallowing roundworm eggs, which contain infective larvae. The larvae hatch in the pet's stomach and small intestine then migrate through the muscle, liver, and lungs. After several weeks, the larvae make their way back to the intestine to mature. When these worms begin to reproduce, new eggs will pass in the pet's stool and the life cycle of the parasite is completed.

Roundworm eggs passed in another animal's stool may be infectious to other pets. Many animal species harbor roundworms and represent potential sources of infection for dogs and cats, including cockroaches, earthworms, chickens, and rodents.

Hookworms: These are intestinal parasites with hook-like mouth parts used for attachment to the intestinal wall. Pets are infected by swallowing hookworm larvae or immature worms through routine grooming or the ingestion of soil or other contaminated substances in the environment. The larvae may penetrate the skin and migrate to the intestine to mature and complete the life cycle. If a pregnant dog has hookworms, the pregnancy may reactivate larvae. These larvae enter the female's circulation and are passed to the puppies through the placental blood flow. Finally, puppies become infected through the mother's milk. Once a pet is infected, the hookworm attaches to the lining of the intestinal wall and feeds on blood. Its eggs are ejected into the digestive tract and pass into the environment through the pet's feces, which potentially increases exposure to other animals. In dogs, many hookworms cause anemia. This problem is most common in puppies, but it occasionally occurs in adult dogs.

Tapeworms: These are long, flat worms that attach themselves to the intestines. A tapeworm body consists of multiple segments, each with its own reproductive organs, which are passed into the pet's feces. Tapeworm infections are usually diagnosed by finding these segments, which resemble white grains of rice or seeds, in the pet's stool, on their anus, or where they live and sleep. Pets that ingest a flea containing tapeworm eggs can become infected. Fleas are accidentally ingested upon licking or chewing the skin. The flea is digested within the intestines and the tapeworm hatches, after which it attaches to the intestinal lining.

Whipworms: These parasites live in the cecum and colon where they cause severe irritation to the lining of those organs that result in watery, bloody diarrhea, and weight loss. They are one of the most harmful worms to pets, if not properly treated. Pets become infected by ingesting eggs in soil or other contaminated substances in their environment. Eggs are very resistant to drying and heat, which allows them to remain viable in the environment for years. Once laid, the eggs mature to an infective stage and reinfect within 10–60 days. When the eggs are swallowed, they return to the lower intestinal tract to complete the life cycle.

Coccidia: This parasite is a single-celled organism that infects cats and dogs through contact with fecal matter that contains the parasite. Infection occurs following eating contaminated soil, drinking contaminated water, or licking paws and fur that encountered infected feces.

After infection, coccidia enters the intestines and destroys the intestinal lining, which prevents the absorption of nutrients. This causes severe diarrhea and

dehydration, which can even lead to death. Coccidia is very contagious to puppies and kittens, so frequently cleaning feces and changing water to prevent contamination is especially important in young pets.

Giardia: This is another single-celled intestinal parasite that infects dogs, cats, and humans. Infection is caused by ingesting contaminated food, water, soil, or fur. It travels to the intestines and damages the lining of the intestinal wall, which reduces the absorption of nutrients. Infections often have no symptoms. If there is diarrhea, there is usually no blood in the stool.

1.3 Diagnosis, Treatment, and Prevention

Examine stool samples to test for the presence of microscopic eggs laid by adult worms. Intestinal worms are treated with a dewormer. Preventing infection by intestinal parasites is highly dependent on good sanitation practices.

Treatment is mainly important because of the public health significance. Effective drugs for all tapeworm species include praziquantel and epsiprantel. Although single doses are usually sufficient, an additional dose may be required for some species. There are several alternative anthelmintics that are less frequently used, including bunamidine and nitroscanate; the latter is not recommended for cats. Bemidazole drugs are only effective against taenid tapeworms.

1.4 Control

Clean up droppings as quickly as possible to prevent the spread of infection.

A source of fresh, clean water should be available as parasites are found in contaminated water.

Prevent pets from eating soil or grass, which can contain parasitic eggs.

Remember that droppings from other dogs might be infested – be sure that your dog does not interact with these while out on walks.

Use monthly heartworm preventive medicine.

Use monthly flea prevention treatment to prevent parasite transmission from infected fleas.

- Flea control is essential to control *Dipylidium caninum*. Unless exposure to infected fleas can be prevented, dogs and cats will become reinfected with *D. caninum*.
- Infection by other species can only be prevented by also controlling predatory and scavenging behavior that involve the metacestodes (larval stage) in carrion and prey animals.

Wash your hands after playing with pets and be sure that outdoor play areas for children, like sandboxes, do not contain any animal droppings.

The major symptoms of worm infections in human include:

- Irritability, weight loss, stomachache, bed wetting, and blood in stools.
- **Tapeworm infection** – Jaundice, nausea, vomiting, loss of appetite, eating too frequently, and sometimes even malnutrition.
- **Roundworm infection** – Diarrhea, passing worms with stools, a dry cough, and fever.
- **Pinworm infection** – Itching around the anus, trouble sleeping due to itching, and painful urination.
- **Hookworm infection** – Wheezing, coughing, fatigue, and anemia.

The common causes of infection in human involves:

- Encountering an infected surface such as soil that contains eggs, germs at a playground, or touching pets infected with worms.
- Consuming infected food or water.
- Improper hygiene.
- Inadequate hand washing.

The diagnosis of infection plays an important role. A thorough fecal examination and a review of the symptoms are necessary.

Treatment:

- Anti-parasitic medicines.
- Anti-worm or deworming medicines.
- Follow good hygiene practices while taking medication for quicker and effective recovery.

1.5 Internal Parasites

There are three groups of internal/helminth parasites: trematodes, cestodes, and nematodes. A list of common dog and cat parasites includes:

Cestodes:

- 1) *Dipylidium caninum*, a common tapeworm of dogs and cat.
- 2) *Taenia* spp.
Various species include *Taenia taeniaeformis* in cats as well as *T. pisiformis*, *T. multiceps*, *T. hydatigena*, and *T. ovis* in dogs.
- 3) *Echinococcus* spp. Common name: Dwarf dog or fox tapeworm.
E. granulosus and *E. multilocularis* infect dogs and wild canids. Cats are infrequently infected with *E. multilocularis*.

- 4) *Mesocestoides* spp.
Mesocestoides corti, *M. lineatus*, and *M. variabilis*.
- 5) *Diphyllobothrium latum* Common name: Broad fish tapeworm.
- 6) *Spirometra* spp. Common name: Zipper tapeworm.
Spirometra mansonioides are endemic to North and South America, and *S. erinaceieuropaei* is endemic to Europe and Asia.

Nematodes:

Dirofilaria immitis: Heart worm in dogs.

Infects mainly dogs but also cats, ferrets, and some other animals.

Angiostrongylus

Ascariasis

Hookworms in cats

Whipworms in dogs

Lungworms in cats

Lungworms in dogs

Threadworms: Strongyloidosis

Stomachworms

Ollulanus infection

Esophageal worm in dogs

Diocotophyma renale: kidney worm in dogs

Dracunculus infection

Pelodera strongyloides

Thelazia: eyeworm

Capillaria urinary infection

Angiostrongylus infection

A. vasorum

French heartworm: Dogs are the definitive host and adults are found in pulmonary vessels.

Ancylostoma spp.

Uncinaria stenocephala: Common name: Hookworm.

Order: Strongylida.

Ancylostoma caninum (dogs)

brasiliense (dogs and cats)

tubaeformae (cats)

ceylanicum (dogs and cats)

U. stenocephala (dogs, rarely cats)

Roundworms (Ascariasis):

T. canis (infects dogs and foxes)

T. cati (infects cats and wild Felidae)

Toxascaris leonina (infects dogs, foxes, cats, and wild Felidae)

Trichuris vulpis: Whipworm

Infects the cecum and large intestine of dogs and wild canids. *Trichuris felis* infection has been reported, rarely, in cats in Latin America and Australia.

Spirocercalupi

Common name: Esophageal worm.

Adults are found in the wall of the esophagus, stomach, and rarely the aorta of dogs, wild canids, and various other wild animals.

Strongyloides stercoralis

Common name: Intestinal threadworm.

Location in host: Adult females live in the canine small intestine.

Angiostrongylus vasorum

Common name: French heartworm.

Location in host: Lives in the pulmonary arteries and right ventricle of dogs and foxes.

Cestodes: *Dipylidium caninum*

Common name: Double-pored or cucumber seed or flea tapeworm.

Location in host: Infects the small intestines of dogs and cats.

Taenia spp.

This species infects small animals, including *T. taeniaeformis* in cats and *T. pisiformis*, *T. multiceps*, *T. hydatigena*, and *T. ovis* in dogs.

Echinococcus spp.

Common name: Dwarf dog or fox tapeworm.

E. granulosus and *E. multilocularis* infect dogs and wild canids.

Cats are infrequently infected with *E. multilocularis*.

Location in host: Lives in the small intestines.

Mesocestoides spp.

Species include *M. corti*, *M. lineatus*, and *M. variabilis*.

Location in host: Infects the small intestine of dogs, cats, various wild mammals, and birds.

Diphyllobothrium latum: Common name: Broad fish tapeworm.

Dogs and cats can also be infected with *D. dendriticum*.

Location in host: Found in the small intestines of dogs, cats, pigs, humans, and various other fish-eating mammals.

Cestode: *Spirometra mansonioides* are endemic to North and South America and *S. erinaceieuropaei* to Europe and Asia.

Location in host: Live in the small intestines of cats, dogs, and wild animals.

Trematodes:

Paragonimus kellicotti

Infections of domestic animals, humans, and wildlife occur in South and Central America, Africa, and Asia.

Location in host: Infects the lung parenchyma of cats, dogs, pigs, goats, minks, and various other wild mammals.

Nanophyetus salmincola

Common name: Salmon poisoning fluke.

Location in host: Infects the small intestines of dogs, cats, and various other piscivorous carnivores.

Hookworms in cats:

Ancylostoma tubaeforme (most common)
brasiliense

Uncinaria stenocephala

Kittens and young cats are most susceptible.

Tricuris campula, the whipworm of cats, rarely infects dogs.

Lungworms in cats:

Aelurostrongylus abstrusus (principal lungworm of the cat)
or *Capillaria aerophila* (less frequent in cats).

Filaroides hirthei: Sporadic infections in cats with this small nematode have been reported worldwide.

Additional feline lungworms – There are other lungworms in cats, especially, *Mammomonogamus* spp.

Lungworms in dogs:

Three species of lungworms are recognized in dogs: *Oslerus (Filaroides) osleri*, *Filaroides milksi*, and *Crenosoma vulpis*.

Strongyloidosis (thread worms):

Four species:

- 1) *Strongyloides stercoralis* (most common in dogs and humans, rarely in cats).
- 2) *S. planiceps*, *S. fuelliborni* (less common in dogs).
- 3) *S. cati* (in cats, mainly in Southeast Asia).
- 4) *S. tumefaciens* (occurs rarely in cats).

Stomachworms:

Physaloptera parasitize the stomachs of dogs and cats worldwide.

Ollulanus infections:

Ollulanus tricuspis, a small nematode about 1 mm long that occasionally causes a mild catarrhal gastritis in cats.

Esophageal worm in dogs:

Spirocerca lupi, a bright red nematode worm.

Worms are found in the nodules that they produce in the esophageal, gastric, and aorta walls.

Dictyophyma renale infection (giant kidney worm):

Dictyophyma renale, a large, red nematode.

The definitive hosts of this large nematode are mink, weasels, otters, skunks, martens, seals, and infrequently, dogs and some other animals.

Dracunculus infection:

Dracunculus insignis is a white nematode found in the subcutaneous connective tissue of wild carnivores, raccoons, mink, and rarely, in dogs.

Pelodera strongyloides infection:

P. strongyloides is a very small (1–2 mm long), free-living nematode with a worldwide distribution that may superficially infect the skin of dogs, rodents, and other animals.

Thelazia (eyeworm) infection:

Thelazia spp. are small (up to 19 mm long), white nematodes found in the eyes of dogs, cats, and other animals.

Capillaria urinary infection:

Capillaria spp. are thread-like nematodes, the females of which are up to 60 mm long. Two species of these bladder worms occur in dogs and cats. *Capillaria plica* infects dogs, cats, wolves, and foxes; *C. feliscati* infects cats.

Acanthocephalans (thorny-headed worms: Onciola and Macracanthorhynchus):

These parasites, referred to as thorny-headed worms, are in the small phylum Acanthocephala.

Two thorny-headed worms infect dogs, *Oncicola* spp. and *Macracanthorhynchus* spp.; the former species can also infect cats. *Oncicola* spp. is discussed first, followed by *Macracanthorhynchus* spp.

Onciola infection:

Oncicola canis is a small, white worm 6–14 mm long. It has a thorny head, which it imbeds in the mucosa of the small intestine.

The definitive hosts are dogs, cats, bobcats, and coyotes.

Macracanthorhynchus infection:

The thorny-headed worm *Macracanthorhynchus ingens* is large (8–12 cm long), white, wrinkled, and found in the small intestine.

The definitive hosts are raccoons and occasionally dogs.

1.6 General Measures for the Prevention of Worm Infections

- The primary strategy is to destroy parasitic eggs and larvae before they infect an animal.
- Good general sanitation and maintaining clean, dry quarters.
- Avoid dirt kennel runs; cement, gravel, or sand is preferred, the latter two provide good drainage. Cement runs should be hosed down daily and a disinfectant (e.g. 1% bleach) applied frequently.
- Lime, rock salt, or borax can be added to cement, gravel, and sand runs to kill larvae.
- Remove stools as often as possible.
- The lawns where pets range should be kept short and watered sparingly. Exposure is greatest in damp, shady areas.
- Remember that fleas, mice, and other rodents are intermediate hosts for tapeworms.
- Keep the litter box clean. Wet spots and feces should be removed daily. Empty and disinfect the box weekly.
- Keep pets indoors as much as is possible.

- The more pets are allowed to roam and hunt outdoors, the greater their exposure to parasitic infection. Carrion, dead and live rodents, earthworms, frogs, and other animals are potential intermediate and paratenic hosts.
- In the interest of preventing zoonotic infections, clients (and through them their children), should be made aware of the need for good hygienic practices when handling pets. Collect and dispose of cat and dog feces where children play.

1.7 Anti-helminthics and Deworming Guidelines

These guidelines are adapted in part from recommendations of the American Association of Veterinary Parasitologists and the Centers for Disease Control and Prevention. These guidelines can serve to assist practitioners in the preparation of deworming programs for clients. In view of the introduction of some new anthelmintics, it may not always be necessary or feasible to adhere strictly to these recommendations. The potential for exposure to infection is different for each situation and must be taken into account. A list of frequently used anti-helminthics and their range of efficacy is presented in Table 1.1.

Juveniles:

- Puppies: treat at two, four, six, and eight weeks.
- Kittens: treat at six, eight, and ten weeks.
- Puppies and kittens: treat once a month from three to six months of age.
- After six months, follow adult recommendations.

Adults:

- Treat regularly depending on the potential exposure to parasites; ordinarily, not more than four times a year.

Breeding females:

- Once prior to mating.
- Once following parturition.

References

- 1 Robertson, I.D., Irwin, P.J., Lymbery, A.J., and Thompson, R.C. (2000). The role of companion animals in the emergence of parasitic zoonoses. *International Journal of Parasitology* 30 (12-13): 1369–1377.
- 2 Schantz, P.M. (1994). Of worms, dogs and human hosts: continuing challenges for veterinarians in prevention of human disease. *J. Am. Vet. Med. Assoc.* 204: 1023–1028.
- 3 Okaeme, A.N. (1985). Zoonotic helminths of dogs and cats at New Bussa, Kainji Lake area, Nigeria. *International Journal of Zoonoses*. 12 (3): 238–240.
- 4 Urquhart, G.M., Armour, J., Duncan, J.L. et al. (1987). *Veterinary Parasitology*, 1e, 250. Published by Churchill Livingstone USA.

Table 1.1 Anti-helminthics and their range of efficacy expressed as the animal and worm infectious groups that can be treated.^{a, b}

Anti-helminthic	Efficacy	Animal
Febental/praziquantel/pyrantel pamoate	+ + + + +	Dogs
Febental/praziquantel	+ + + + +	Dogs, cats
Febendazole	+ + + +	Dogs
Mebendazole	+ + + +	Dogs
Dichlorophene/toluene	+ + + +	Dogs
Pyrantel pamoate/praziquantel	+ + + +	Cats
Dichlorvos	+ + +	Dogs, cats
Milbemycin oxime	+ + +	Dogs
Oxibendazole/diethyl/carbamazine	+ + +	Dogs
Febentel	+ + +	Dogs
Ivermectin/pyrantel pamoate	+ +	Dogs
N-butyl chloride	+ +	Dogs, cats
Pyrantel pamoate	+ +	Dogs
Piperazine salts	+	Dogs
Diethylcarbamazine citrate	+	Dogs, cats

^a Information in this table adapted from recommendations of the Centers for Disease Control and Prevention.

^b (Products should be used according to manufacturer's recommendations)

- Lactating females should be treated concurrently with their litter(s).

Newly acquired animals:

- Immediately treat; then repeat after two weeks and then follow the guidelines above.

Screening:

- Annual or biannual fecal screening is recommended for adult cats and dogs.

